Space Weather Technical Forecast

Issued on Sunday, 17 September 2023 at 13:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated G1-G2 minor/moderate storms to start. G1-G2 minor/moderate storm intervals expected into Tuesday 19th September however, with a likely CME arrival bringing a slight chance of a G3/Strong storm. Chance of isolated R1 Minor Radio Blackouts throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours. There are currently six sunspot regions on the visible disc, with a newly numbered AR3435 arriving on the eastern limb. This looks to be a bi-polar region but further classification will only become clear in the coming hours and days. By far the most active spot over the last few days remains AR3429, but this region has continued to see weakening and fragmentation within its central portion, losing its delta spot, and is now classified Dai/Beta with a corresponding slight reduction in flare risk. AR3425 in the northwest looks to be fading with an as yet unnumbered NEW region forming quickly to its southeast over the last 12hrs, this region will need monitoring and for now helps to maintain total flare risk. AR3434 faded with all other sunspot regions stable.

No Earth CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR/ACE at L1, were at slightly elevated levels to start, around 410-430km/s with some coronal hole influence likely ongoing. From approximately 17/0200 UTC winds increased to 470-500km/s following the likely arrival of the CME associated with a flare on the 14th, and have been slowly declining. The solar wind density was average to below average until the arrival of the CME, increasing to above average with a peak of around 17ppcc before declining slowly. The IMF was steady and weak initially, below 6nT, but increased with the CME to become erratically moderate with a peak of around 11nT. The north-south component was also weak to start within a typical range of +/-5nT but became briefly moderately negative with the arrival of the CME, with a minimum of -9nT but subsequently becoming predominantly positive. the phi angle has been highly variable throughout. The net result of the above solar wind measures was for provisionally Quiet to Unsettled geomagnetic activity.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at Background levels. GOES16 high energy (greater than 2MeV) electron flux was at Normal Background to Moderate levels. The associated 24-hour fluence was well below the Active threshold, with 6.52e6 integrated pfu observed at 17/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low activity expected, but there remains a chance of isolated M-Class flares throughout the period.

Solar Wind / Geomagnetic Activity: The geomagnetic forecast is of lower than average confidence with multiple potentially Earth directed CMEs, for a full discussion please see the

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Geomagnetic Storms section.

The large filament eruption and associated CME which occurred early on the UTC day of 16 Sep has been analysed and modelled in Enlil, which suggests a likely Earth directed component with an arrival time later on Day 3 (19 Sep).

CME influence waning initially with generally Quite to Unsettled conditions day 1 (17 Sep), though there remains slight chance of G1 minor storm intervals. A further chance of G1 from a potential second CME follows into day 2 (18 Sep). G1-G2/Minor-Moderate storm intervals expected into day 3 (19), with a Chance of a G3/strong storm due to the expected arrival of the large CME from the filament eruption on 16 Sep, potentially combined with coronal hole influence. CME and coronal hole effects perhaps lingering into day 4 (20 Sep) but likely waning somewhat.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with a daily slight chance of an enhancement should any larger flares occur.

High energy (greater than 2 MeV) electron flux is likely to be suppressed at Normal Background levels at GEO through much of the period, but perhaps with reduced confidence given likely CME influence. Overall, the 24-hour fluence is expected to remain below the Active threshold throughout the period, with reducing confidence into the new UTC week.

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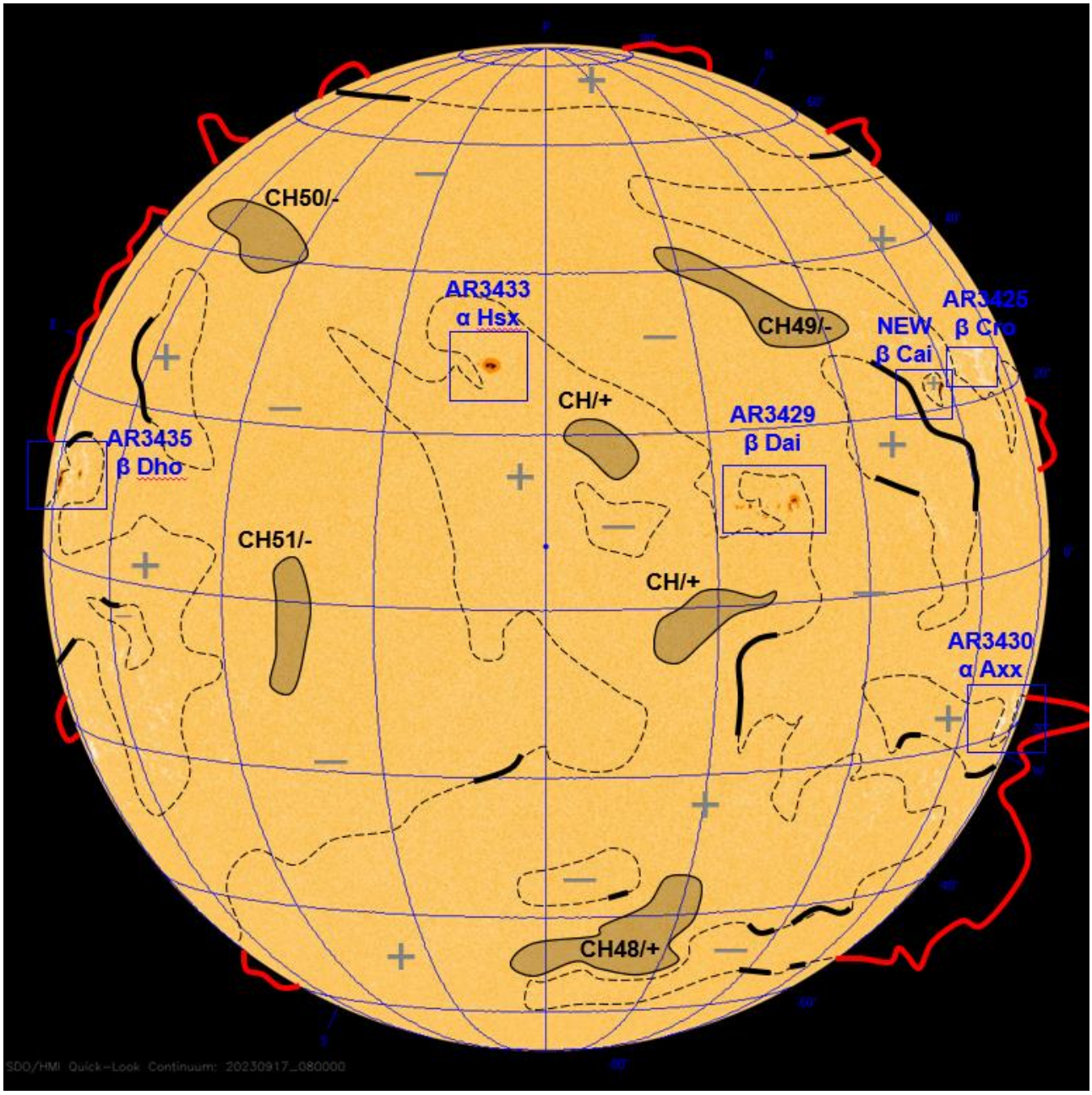
Figure 1. Solar Analysis Valid 17/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:
There are currently three CMEs that feature in the forecast.

The first CME in the forecast was from a large filament eruption in the northwest, associated with an M1.4 flare near AR3423 around 14/0745UTC. This feature likely passing through the near Earth environment currently.

The second CME was likely associated with an M2.4 flare from AR3229 at 14/2126UTC. With a possible glancing arrival suggested day 2 (18 Sep).

The third and probably the most significant CME in the forecast is from a large filament eruption, which occurred early on the UTC day of 16 Sep. The large filament has been dominant in the central-north disc and was seen lifting off the disc early on 16 September, perhaps destabilised by a series of M-class flares from the nearby AR3429. This produced a asymmetric halo CME seen clearly in LASCO-C2 and C3 coronagraph imagery, also STEREO-A, with the bulk of the material heading to the south and west. The CME has been analysed and modelled in Enlil, which suggests a likely Earth directed component with an arrival time later on Day 3 (19 Sep). Outside of CME influence the solar wind sees lower than average forecast confidence through the period, complicated by the potential influence from one or more coronal holes. With CH49/- in the northwest and and two unnumbered coronal holes in the center disk perhaps having an impact from late day 2 onwards. The unnumbered coronal hole areas have only fairly recently appeared, uncovered perhaps by the filament lift off responsible for the above mention CME. A lack of reliable persistence data further reducing confidence and ENLIL model output has likely not yet assimilated these features.

CME influence waning initially with generally Quite to Unsettled conditions day 1 (17 Sep), though there remains slight chance of G1 minor storm intervals. A further chance of G1 from the second CME follows into day 2 (18 Sep). G1-G2/Minor-Moderate storm intervals expected into day 3 (19), with a Chance of a G3/strong storm due to the expected arrival of the large CME from the filament eruption on 16 Sep, potentially combined with coronal hole influence. CME and coronal hole effects perhaps lingering into day 4 (20 Sep) but likely waning somewhat.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	80	60
Strong	G3	No	1	5	30	10
Severe	G4	No	1	1	2	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1159	Partial	Filament eruption	NW near AR3432	800km/s	UTC evening 16 Sep	Likely moving through now
15/0600	Partial	AR3429	M2.4 flare	500km/s	18/1200UTC	Glancing blow

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16/0800-1000UTC	Full	Filament eruption	Center-disc	635km/s	19/1200 UTC +-6hrs	Low confidence, but potentially impactful

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Radio Blackouts - X-Ray Flares:
The most active flare producing region over the last few days remains AR3429, but this region has continued to see weakening and fragmentation within its central portion, losing its delta spot, and is now classified Dai/Beta with a corresponding slight reduction in flare risk. Future evolution remains uncertain with the potential for further development but for now a declining picture and reduced flare risk is accepted. The quickly developing NEW region in the northwest also requires monitoring.

In terms of the forecast, activity is expected to remain generally low given the weakening observed within AR3429, but there remains a chance of further M-class flares from this region, or perhaps the quickly developing NEW region in the northwest though this region will leave the disk towards the end of the period. The potential for activity from the newly numbered AR3435 remains to be fully assessed and this, combined with the likelihood of further regions rounding the eastern limb during the period helps to maintain flare risk.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at Background levels. There remains a daily slight chance of flux levels rising in response to any significant flaring, particularly from AR3429 as it rotates across the western disk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):
High energy (greater than 2MeV) electron flux levels are currently at Background levels. An uncertain forecast during the period, with geomagnetic activity associated with the expected arrival of one or CMEs in the coming days likely to impede any prolonged rise. The environment remains potentially conducive to some increase in flux levels however, with the some continued coronal hole influence into the period likely.

The 24-hour fluence is currently below the active threshold, with current MOSWOC REFM model output likely providing reasonable guidance. Forecast is lower confidence however given uncertainties above, with an increasing risk of breaching the active threshold into the period.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	15
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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